

# REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 074-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503

<b>1. AGENCY USE ONLY (Leave blank)</b>			<b>2. REPORT DATE</b> November 1992	<b>3. REPORT TYPE AND DATES COVERED</b> Magazine
<b>4. TITLE AND SUBTITLE</b> Gateway: Volume III Number 4			<b>5. FUNDING NUMBERS</b> SPO900-94-D-0001	
<b>6. AUTHOR(S)</b> Dieter W. Jahns Brian Shackel Mark A. Hofmann Daniel J. Weintraub				
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> Human Systems IAC 2261 Monahan Way, Bldg. 196 WPAFB OH> 45433-7022			<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b> GWIII4	
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> Defense Technical Information Cntr. DTIC/AI Cameron Station Alexandria, VA 22304-6145			<b>10. SPONSORING / MONITORING AGENCY REPORT NUMBER</b>	
<b>11. SUPPLEMENTARY NOTES</b>				
<b>12a. DISTRIBUTION / AVAILABILITY STATEMENT</b> Approved for public release; distribution is unlimited. Free to public by contacting the Human Systems IAC.			<b>12b. DISTRIBUTION CODE</b> A	
<b>13. ABSTRACT (Maximum 200 Words)</b>  This issue contains articles on the following subjects: 1. Credentials, Criteria, and Certification of Ergonomists; 2. A Short History of Human-Computer Simulation; 3. Human Factors in the Federal Aviation Administration; 4. Issues in Head-Up Display Design: The Book of HUD; 5. Defining Human Factors				
				
<b>14. SUBJECT TERMS</b> Operator Workload    Human-Computer Interaction    Federal Aviation Administration    Head-Up Displays    Human Factors			<b>15. NUMBER OF PAGES</b> 20	
			<b>16. PRICE CODE</b>	
<b>17. SECURITY CLASSIFICATION OF REPORT</b> UNCLASSIFIED	<b>18. SECURITY CLASSIFICATION OF THIS PAGE</b> UNCLASSIFIED	<b>19. SECURITY CLASSIFICATION OF ABSTRACT</b> UNCLASSIFIED	<b>20. LIMITATION OF ABSTRACT</b> UNLIMITED	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)  
Prescribed by ANSI Std. Z39-18  
298-102

# CSERIAC GATEWAY

PUBLISHED BY THE CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER

## In this issue:

Page

- 1 CREDENTIALS, CRITERIA, AND CERTIFICATION OF ERGONOMISTS
- 6 THE COTR SPEAKS
- 6 CALENDAR
- 7 ANNOUNCEMENTS
- 10 A SHORT HISTORY OF HUMAN-COMPUTER INTERACTION
- 13 HUMAN FACTORS IN THE FEDERAL AVIATION ADMINISTRATION (FAA)
- 15 ISSUES IN HEAD-UP DISPLAY DESIGN: THE BOOK OF HUD
- 16 OVERVIEW, OBSERVATIONS, & REACTIONS
- 18 DEFINING HUMAN FACTORS
- 20 CSERIAC PRODUCTS AND SERVICES

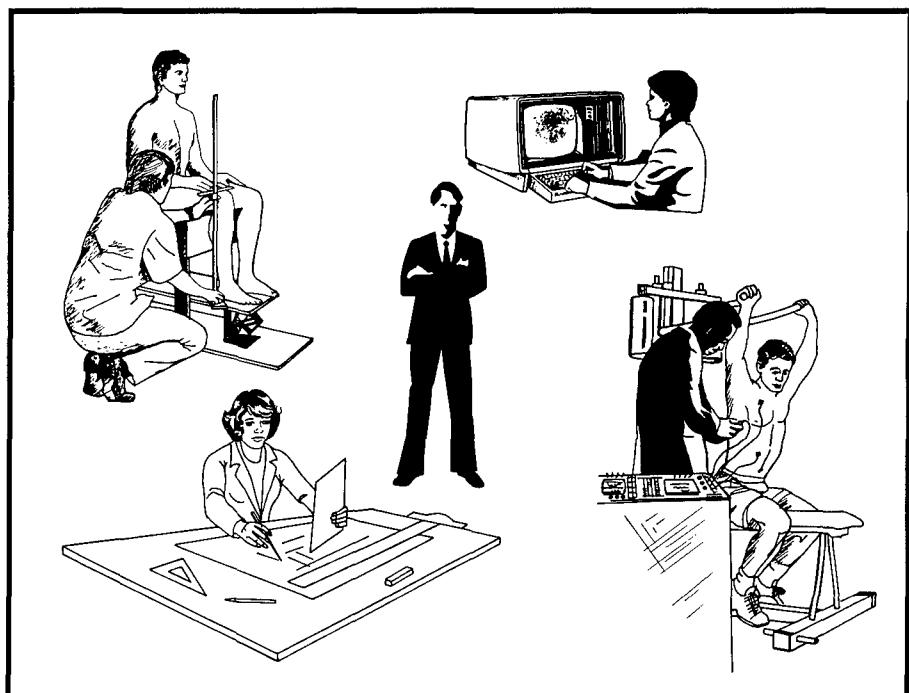


Figure 1. Human factors specialists are derived from many different disciplines. Illustration by Tim Span.

## Credentials, Criteria, and Certification of Ergonomists

Dieter W. Jahns

**T**wenty years ago I tackled a research project titled "Operator workload: What is it and how should it be measured?" I quickly found that this was a multifaceted problem in which the answer depended on whom you asked. Three years ago I asked an even more impertinent question: "What's an ergonomist and how should her/his performance be measured?" The question is not original. As readers of the CSERIAC *Gateway* know, it is a favorite topic of some well-known practitioners of the profession: Chapanis, Boff, Rouse, and Cacioppo come to mind. This answer also depends on whom you

ask. A recent National Research Council report (Van Cott & Huey, 1992) indicates that only 66 percent of people working in "human factors" consider themselves human factors specialists. The remainder mainly prefer calling themselves industrial engineers, engineers other than "industrial," psychologists, computer scientists, or industrial designers (see Fig. 1). Even officers of the Human Factors Society (HFS) often prefer to be known by their more traditional disciplines of origin, and the Society promotes itself as "an interdisciplinary, nonprofit organization of professional people involved in the

*Continued on page 2*

CSERIAC is a United States Department of Defense Information Analysis Center administered by the Defense Technical Information Center, Alexandria, VA, managed by the Armstrong Laboratory, Wright-Patterson Air Force Base, OH, and operated by the University of Dayton Research Institute, Dayton, OH.

## DISTRIBUTION STATEMENT A

Approved for Public Release  
Distribution Unlimited

# GATEWAY

human factors field" (HFS, 1992, p. 1).

I submit that therein lies the biggest obstacle to developing professional standards for ergonomists. Pressed for differentiating between ergonomics and their discipline of origin, many professionals reveal a disproportionate allegiance to the academic discipline in which they received most of their training, be it psychology, engineering, health sciences, safety, industrial design, or whatever. Thus the core, specialized, and extensive knowledge base of ergonomics (academic training in research methods, design orientation gained by experience, and a special perspective of the systems approach) is then diluted by overemphasis on the discipline of origin. The problem was exacerbated in the 1980s when the Occupational Safety and Health Administration (OSHA) linked ergonomics to health issues in industry. Ergonomic hazards were correlated with musculoskeletal disorders, and ergonomics was "captured" by therapists and health care providers. Ergonomic hazards now often refer to workplace conditions that pose biomechanical stress to the worker, and, at least according to OSHA, medical management has to be part of an ergonomic program.

So here we are with a profession that has matured over the past 50 years, yet still struggles with at least 74 definitions of its subject matter and domain (Licht, Polzella, & Boff, 1991). The situation would be ripe for "turf battles," were ergonomists less stoic and less civilized.

I believe the solution to our dilemma lies in examining the record of our profession from a new perspective. Is there a unique consistency that has held over the years? Yes, there is. Ergonomics has always consisted of three inseparable components: human performance (work) + engineering (design) + systems integration (technology management). Take any component by itself, and you get a large variety of allied professions but you do not have ergonomics. Viewed this way, ergonomics is not interdisciplinary but

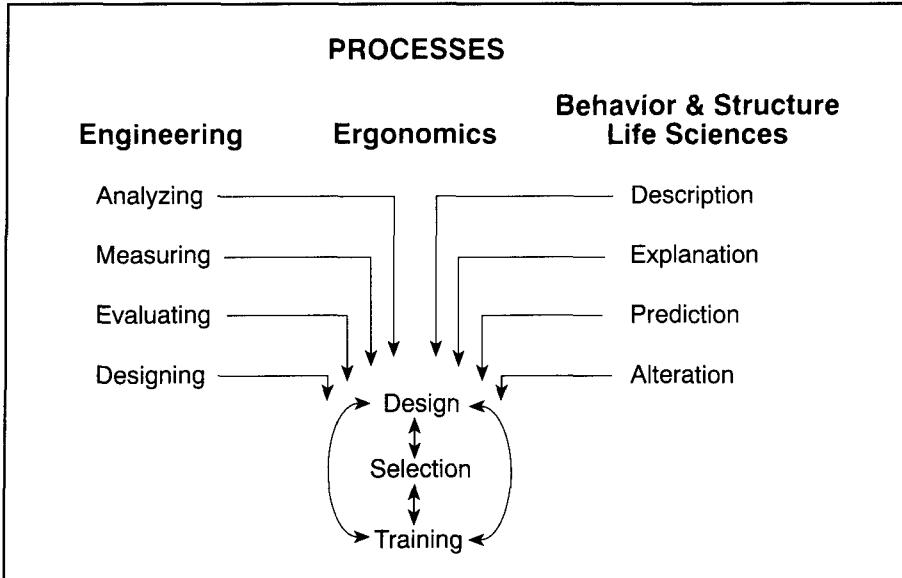


Figure 2. The transdisciplinary process of ergonomics.

transdisciplinary. We work in interdisciplinary teams when we tell engineers about people-centered design requirements relative to "materialistic" design priorities. But since nobody likes to be told how to design, we had better be prepared to do the necessary ergonomic design ourselves and jointly integrate the human component into the system. The human is a non-expendable system component, so performance, safety, and health are design criteria that should assume equal weight. This, in turn, means that the ergonomist may want to consult with a behavioral, social, or medical professional to aid the design process. For example, for g-induced loss of consciousness in pilots of fighter aircraft, or cumulative trauma disorders in workers who assembled the fighter plane, I would like to have medical professionals be able to tell me what is causing these problems. Figure 2 tries to show in a simplified way how ergonomics becomes transdisciplinary by combining engineering processes and life sciences processes. Of course, ergonomists have one advantage over engineers: the ergonomist's system component (the human operator) can think, talk, and act. Thus the human operator should become part of the design team.

There has been another historical consistency: ergonomics has always been the science and technology of human work —both vocational and avocational. In the U.S. we have sometimes "hidden" this fact by our close alliance with systems engineering methodology and our involvement with advanced technology systems (e.g., aerospace, computers, ground transportation, energy, communications). For industrial processes, that has sometimes slowed application advances. With over 30,000 members in the Institute of Industrial Engineers, only 1,200 people are members of its Ergonomics Division. Stan Lippert, a founder and Past-President of the Human Factors Society, said many years ago that human factors (to me synonymous with ergonomics) was the only profession that sought to improve the life of the ordinary individual by means of technology. It is likely that with OSHA's interest in ergonomics the lower technology industries will become more aware of using ergonomists.

Perhaps a better balance can be achieved between "systems thinking" and "work-task thinking" if we structure our professional efforts within the framework of the matrix shown in Figure 3 (partially derived from Rohmert, 1987). I believe all human

# GATEWAY

work (from that of astronauts to that of potato farmers) can be categorized in terms of one, or more, of the working tasks shown, and a technology improvement achieved by means of the ergonomist's job functions. That type of thinking can also lead to better technology transfer across diverse systems and productive jobs.

Application of the inseparable components of ergonomics is shown in Figure 4, which is an update of a diagram first used in 1967 by W. T. Singleton (1971). Here again, it can be seen that the ergonomist's job functions are transdisciplinary, task dependent, and systems development oriented. The human as a system component is a (functional) design resource (not just the "ultimate" object for study) who is most complex, highly adaptive, relatively fragile, and not always rational, with both physical and emotional needs. As such, the human species has developed many support systems, sci-

ences, and vocations. Most of these are "treatment" or "therapeutic" disciplines (e.g. education, medicine, law, economics). Ergonomists have to integrate and facilitate the best knowledge about human abilities, human limitations, and other human characteristics for use in the engineering design process. They are analyzers, synthesizers, and evaluators.

## Credentials

According to a survey conducted by the NRC Committee on Human Factors (Van Cott & Huey, 1992), 52% of ergonomics/human factors academic programs are affiliated with university engineering departments, 40% with psychology departments, and 8% with other departments. The vast majority of programs were established in and since the 1960s. Fully 35% of all programs were started in the 1980s. Consequently, some senior members of

the profession may have received their formal education before educational institutions were offering courses or programs in ergonomics or human factors. Think of ergonomics as a unique profession spanning about three generations. The first generation got their academic degrees in the mid-1930s to mid-1950s. As psychologists, physiologists, physicians, and engineers, they developed an interdisciplinary (or multidisciplinary) foundation for "humanizing technology" based on empirical research pertaining to human functioning in systems. Some of these pioneers were at universities to train the second generation in the 50s through 70s. Other second-generation ergonomists built their own interdisciplinary course-of-study based on hearing about this "new career field" at psychology or engineering departments without the first generation expertise. I am one of those. Biotechnology, bio-

*Continued on page 4*

ERGONOMIST'S JOB FUNCTIONS FOR "TOOLS", ENVIRONMENTS, & PROCEDURES ▶		PROBLEM FORMULATION	SYSTEM CONCEPTUALIZATION	SPECIFICATION OF "KNOWNS & UNKNOWNS"	SYSTEM MODELING / SIMULATION	SYSTEM ANALYSIS & EXPERIMENTATION	SYNTHESIS (DESIGN)	TEST & EVALUATION	LIFE-CYCLE TRACKING (System Modifications or Disposal / Discarding)	
									A) Development	B) Operational
MAINLY PHYSICAL (MECHANICAL)	MUSCULOSKELETAL (Producing force) e.g. Manual materials handling									
	SENSORI-MOTOR (Coordination of motor & sensory organs) e.g. Parts assembly, Typing									
MAINLY NON-PHYSICAL (INTELLECTUAL)	PERCEPTUAL-MOTOR (Converting info into motoric reaction) e.g. Vehicle guidance & control									
	PERCEPTUAL-COGNITIVE (MENTAL) (Transformation from input to output information [symbolic]) e.g. Air-traffic controlling, Bookkeeping									
	COGNITIVE (MENTAL) (Producing / creating information) e.g. Dictation, Designing, Problem solving									

Figure 3. The SynerTech-designated Human-Work Tasks/Ergonomist's Function Matrix.

# GATEWAY

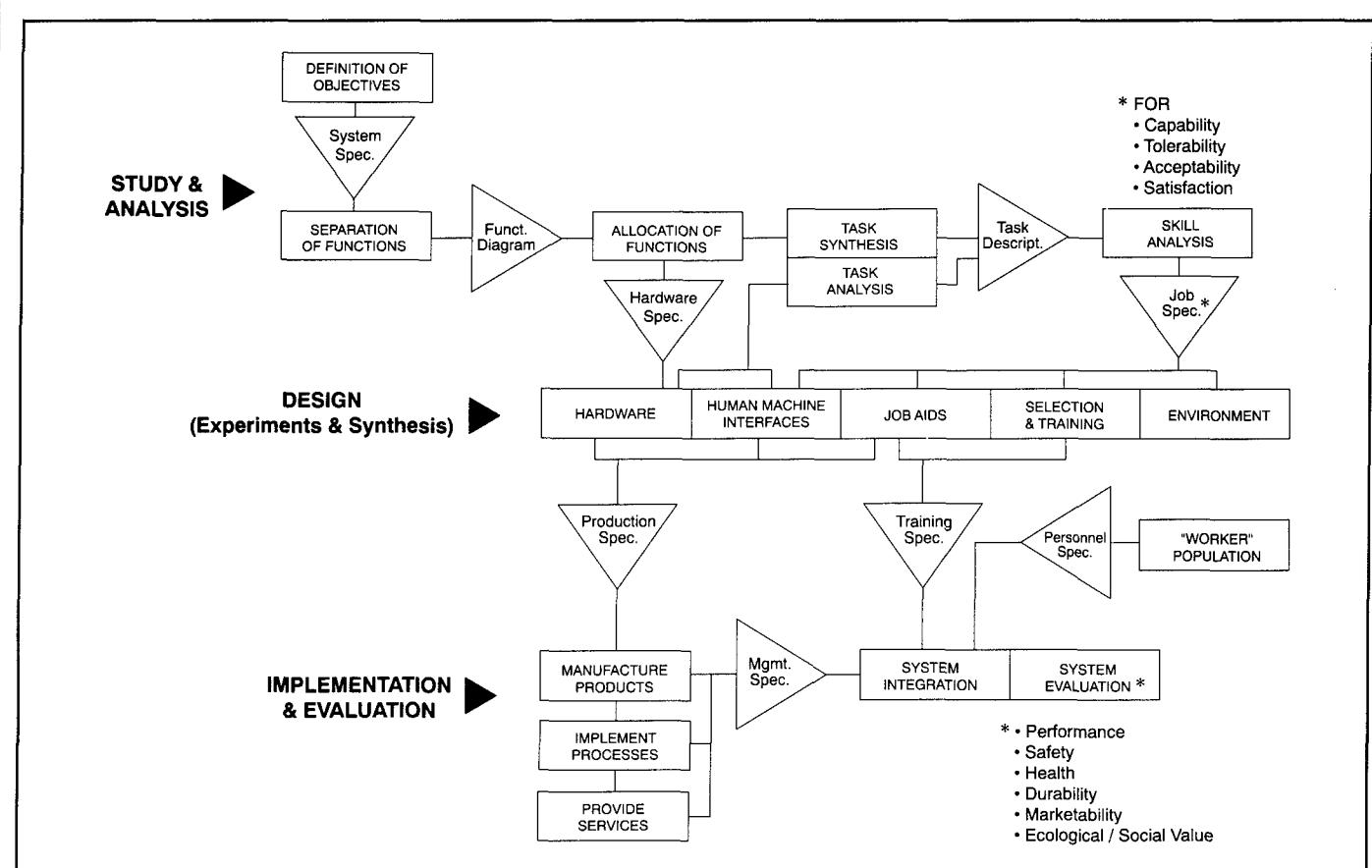


Figure 4. Human-work tasks/ergonomic functions in system development.

mechanics, kinesiology, safety, and industrial hygiene became other foundations for budding ergonomists.

In the 1970s computer science became important and created an instant need for human factors considerations in the development of hardware and software. As the diversity increased, concerns for "quality assurance" within the profession started to surface. HFS began studying the feasibility of accrediting academic programs and/or voluntary certification of practitioners. Several government agencies sponsored definitional studies of the profession. Some of these efforts are cited in Jahns (1991). The net result was that the third generation of ergonomists (those starting graduate school in the 80s and 90s) have had a more structured opportunity for picking relevant courses of study. In 1988 HFS started accrediting academic programs, but "tailed" further involvement with certification development.

## Criteria

The diversity of academic backgrounds among three generations of ergonomists creates some problems for specifying criteria for professional practice. The problems are compounded by an apparent growth-industry to create ergonomists by means of short-courses, seminars, and workshops. The "instant ergonomist" poses problems for the profession and can confuse the public's efforts to distinguish between "good" versus "bad" ergonomics. To deal with these problems, a group of 21 HFS members began discussing the need for a professional certification organization in 1989. A core group of nine individuals volunteered for positions in a new (non-membership) organization dedicated to establishing professional certification for ergonomists and human factors professionals. An executive director was appointed and the Board of

Certification in Professional Ergonomics (BCPE) was incorporated in the state of Washington in 1990 as a non-profit, non-membership, scientific organization. Regular meetings of this group have been held to develop certification criteria, procedures, and general plans.

In developing certification criteria the Board relied heavily on the work done by HFS and others throughout the world in establishing knowledge, skills, and experience requirements. Considering the relative recency of unified ergonomic education programs, it became clear early on that primary emphasis in evaluating applicants would have to be placed on work experience and work products that demonstrated involvement in ergonomic design. Of the three elements of ergonomic practice on which the BCPE certification is based (analysis, design, testing/ evaluation), design is the element that most distinguishes

ergonomics from other related disciplines. Ultimately all iterative analysis and/or testing/evaluation efforts should have design implication. The knowledge base should be life sciences- and engineering sciences-oriented. Here the criteria closely parallel HFS accreditation guidelines and curricula development efforts promoted in Europe, as well as elsewhere, with the assistance of the International Ergonomics Association (IEA). However, given the considerable variety of current graduate programs regarding the breadth and depth with which topics relevant to ergonomics are covered, primary reliance on academic criteria is premature. It is still a fact that practical experience is needed to turn interdisciplinary education into transdisciplinary problem-solving skills for human-centered technology developments. It is through two to five years of practical experience that the maturing ergonomist finds his or her niche on the system development team. To cover the transition period between the evaluation of work products and the written testing of "practices and principles" (scheduled to start in 1994), the current BCPE criterion is seven years of full-time-equivalent work experience in ergonomics.

## Certification

The BCPE has developed a very comprehensive set of instructions, a multi-page application form, and a short, descriptive brochure. These are available from:

BCPE  
P. O. Box 2811  
Bellingham WA 98227-2811, USA  
(206) 671-7601  
FAX (206) 671-7681

Most applicants require one-half to one full day to complete the application and gather the supporting materials. The submitted materials are evaluated in a double-blind fashion by at

least two Board-certified practitioners. The processing fee is \$200.00 (nonrefundable) to cover printing, mailing, administrative and test development expenses. The Board started certifying individuals in June 1992 and is awaiting the return of over 400 applications mailed to individuals who have requested them. The timely return of applications is encouraged to preclude a processing crunch just prior to the procedures change involving mandatory written testing.

The BCPE certification is made available to applicants on an international basis without regard to professional society affiliation. This is in contrast to the practices of the Ergonomics Society (UK) and the Ergonomics Society of Australia which maintain a "Professional Register." Individual members whose names appear on the registers can apply to be designated as practitioners. Also, a working group exists, composed of representatives from a number of European Ergonomic Societies, which is working towards a European registration model for ergonomists. Called "Harmonizing European Training Programmes for the Ergonomics Profession" (HETPEP-working group), the objective is to harmonize training and professional status designations within common standards throughout the European Economic Community (EEC) by creating a professional title of "Eur. Erg." (European Ergonomist). This work appears to be some time away from completion. However, the BCPE is cooperating with these efforts in the hope of creating mutually supportive standards of practice. ●

*Dieter W. Jahns, M.S., CPE, is the Executive Director of BCPE and the principal of SynerTech Associates, Bellingham, WA.*

## Acknowledgments

My research and analysis for professional issues in ergonomics have benefited from the writings and acquain-

tances of many colleagues; some now comprise the BCPE: Alphonse Chapanis, David Meister, Melvin Rudov, Hal Hendrick, George Peters, H. Harvey Cohen, David Cochran, Jerry Duncan, and Steven Casey. I am grateful to all colleagues who have contributed to the professional development of ergonomists (even if they preferred the title human factors professional). However, the thoughts and opinions expressed in this article are mine and do not necessarily reflect the opinions and policies of BCPE or of HFS with which I am affiliated.

## References

Human Factors Society (1992). *Directory and yearbook*. Santa Monica, CA: Author.

Jahns, D. W. (1991). The Education and Certification of Ergonomists: A Practitioners Perspective, *Human Factors Society Bulletin*, 34(8), 4-6.

Licht, D. M., Polzella, D. J., & Boff, K. R. (1991, August). *Human factors, ergonomics, and human factors definitions: An analysis of definitions*. Paper presented at the meeting of the American Psychological Association, Boston, MA.

Rohmert, W. (1987). Physiological and psychological work load measurement and analysis. In. G. Salvendy (Ed.), *Handbook of human factors*. New York: Wiley, 402-428.

Singleton, W. T. (1971). The System Prototype and His Design Problems. In W. T. Singleton, R. S. Easterby, & D. C. Whitfield, (Eds.), *The human operator in complex systems*. London: Taylor & Francis, 20-24.

Van Cott, H. P., & Huey, B. M. (Eds.). (1992). *Human factors specialists' education and utilization: Results of a survey* (National Research Council Committee on Human Factors Report). Washington, DC: National Academy Press.

## The COTR Speaks

Reuben L. Hann

**I**t is hard to believe that CSERIAC is already finishing its fourth year of service to the ergonomics community. We have experienced a steady growth in our customer base, as well as the number of products and publications offered, but we are constantly surprised at the number of persons and organizations that still have no idea of our existence. Since we operate on a cost-recovery basis, it is prohibitive for CSERIAC to advertise in most of the high-circulation commercial journals; we therefore rely in large part on word-

of-mouth advertising. We thank you for your support and ask that you help us get "the word" out to the users of ergonomics information services in government, industry, and academia.

Our lead article in this issue is by a prominent figure in the human factors community, Dieter W. Jahns, who discusses an important issue: the certification of ergonomists. As most readers know, this subject has been discussed and debated for years. Mr. Jahns gives his view of why it has taken so long, and describes the subsequent establishment of the Board of Certification

in Professional Ergonomics (BCPE). This article is "must" reading for all who consider themselves human factors professionals.

In the continuing Armstrong Laboratory Colloquium Series, "The Human-Computer Interface," we were pleased to have Professor Brian Shackel of the Loughborough University of Technology, Loughborough, UK, as one of our speakers. Professor Shackel is Director of the Human Sciences and Advanced Technology Institute at Loughborough and a pioneer in the area of human-computer interaction; he chose the

## Calendar

### October 25-28, 1992

#### Hamilton, Ontario, Canada

Human Factors Association of Canada/Association canadienne d'ergonomie 25th Annual Conference, "The Economics of Ergonomics," at the Hamilton Convention Centre. Contact HFAC/ACE, 6519B Mississauga Rd., Mississauga, Ontario L5N 1A6; (416) 567-7193, fax (416) 567-7191.

### November 2-6, 1992

#### Huntsville, AL, USA

Department of Defense Human Factors Engineering Technical Group (DoD-HFE-TG) Meeting at the Holiday Inn Hotel. Contact Louida Murray, Meeting Administrator, 4476 W. Ponds View Dr., Littleton, CO 80123; (303) 798-2617.

### December 7-10, 1992

#### San Diego, CA, USA

CALSExpo '92 Conference and Exposition, "Catalyst for Competitiveness," coordinated by the Department of Defense and the Department of Commerce, at the San Diego Convention Center. Contact D. Brent Pope, CALS/CE Industry Steering Group, National Security Industrial Association, 1025 Connecticut Ave., NW, Suite 300, Washington, DC 20036; (202) 775-1440.

### November 2-4, 1992

#### San Antonio, TX, USA

Interservice/Industry Training Systems and Education Conference at the San Antonio Convention Center. Contact Galaxy Registration, Inc., P.O. Box 3379, Frederick, MD 21701; (301) 662-9400, fax (301) 662-9411.

### November 5-6, 1992

#### Orlando, FL, USA

National Symposium on "Ergonomics: Future Direction," sponsored by the National Safety Council, at the Orange County Civic Center. Contact National Safety Council Registration and Housing, c/o ITS, 104 Wilmot Rd., Suite 300, P.O. Box 825, Deerfield, IL 60015-0825; (708) 285-1121.

### January 4-7, 1993

#### Orlando, FL, USA

International Workshop on Intelligent User Interfaces, sponsored by ACM SIGCHI and SIGART in cooperation with AAAI and the British HCI Group, at the Buena Vista Palace Hotel, Walt Disney World Village. Contact William Hefley, Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA 15213; (412) 268-7793, Email: ii-Workshop93.chi@xerox.com. *Deadline for papers: July 17, 1992.*

### November 2-5, 1992

#### Alexandria, VA, USA

Defense Technical Information Center (DTIC) Annual Users' Conference "Expanding Horizons in a Changing Environment," at the Old Town Ramada Hotel. Contact Patti Miller, DTIC-BLS, Bldg. 5, Cameron Station, Alexandria, VA 22304-6145; (703) 274-3848.

### November 19-22, 1992

#### Washington, DC, USA

2nd American Psychological Association and National Institute for Occupational Safety and Health Conference on Occupational Stress, "Stress in the 90's: A Changing Workforce in a Changing Workplace." Contact Sonja M. Preston, Project Coordinator, APA, 1200 Seventeenth St., NW, Washington, DC 20002; (202) 955-7699, fax (202) 429-9640.

### April 13-16, 1993

#### Edinburgh, UK

Ergonomics Society Annual Conference "Ergonomics - For Industry," at Heriot Watt University. Contact Conference Manager, Ergonomics Society, Devonshire House, Devonshire Square, Loughborough, Leicestershire LE11 3DW, UK; (44) 509-234904. *Abstract deadline: October 2, 1992.*

Notices for the calendar should be sent at least four months in advance to:

CSERIAC Gateway Calendar, CSERIAC Program Office, AL/CFH/CSERIAC, Wright-Patterson AFB, OH 45433-6573

# GATEWAY

history of this area as his topic for the colloquium. In this *Gateway* we present a summary of his remarks, as edited by Dr. Sarah Swierenga.

Dr. Mark Hofmann of the Federal Aviation Administration's Scientific and Technical Advisor Office for Human Factors tells us how the FAA is incorporating human factors into its planning for the safer and more efficient use of airspace in the future. He describes the basis for the *National Plan for Aviation Human Factors*, as well as many of its features and the important players active in applying the plan.

CSERIAC is pleased to announce the newest publication in its State-of-the-Art Report (SOAR) series: *Issues in Head-Up Display Design: The Book of HUD*, by Dr. Daniel Weintraub. The HUD has been a part of the military aviation inventory for many years,

but now it is being touted as a driving aid in the passenger auto. Dr. Weintraub takes a comprehensive look at these devices. He covers hardware and symbology parameters, as well as a whole series of issues such as design decisions and advantages and drawbacks. Special issues, such as novel applications of HUDs and their future are also discussed. In this issue of *Gateway*, Dr. Weintraub provides us with a summary of his new SOAR. This is a very important publication—one that we feel will evoke broad interest in the ergonomics community. The SOAR is available only through CSERIAC.

*Overview, Observations, & Reactions* is the name of a new feature in this *Gateway*. The intent is to provide comments and observations from attendants at various scientific/technical

meetings within the human factors community. Dr. Aaron Schopper provides his impressions from a recent Department of Defense Human Factors Engineering Technical Group Meeting. His observations should be of interest to all readers, including those outside of government.

Finally, I would like to take this opportunity to once again invite readers to submit articles, or ideas for articles, for the *Gateway*. The article should be of general interest to our worldwide human factors readership of 7000. If you have an idea, please contact me or *Gateway* editor Jeff Landis. ●

*Reuben "Lew" Hann, Ph.D., is the Contracting Officer's Technical Representative (COTR) who serves as the Government Technical Manager for the CSERIAC Program.*

## Announcements

### Online Searching with DGIS and SearchMAESTRO

With hundreds of online databases available, each with its own logon procedure and search language, finding and processing needed information can be overwhelming. The Defense Technical Information Center (DTIC) is offering two systems to help with such online searching.

The Department of Defense Gateway Information System (DGIS) provides access to 20 different online systems with more than 900 different databases. By supplying DTIC with personal account information, DGIS automatically dials and logs onto the selected online system. DGIS can search more than one database at a time, and includes powerful post-processing tools that allow users to reformat and analyze citations in many ways. These features include the elimination of duplicate citations, the ability to merge multiple files into one, sort citations by almost any field, analyze citations, and cross correlate fields. DGIS will arrange citations from BRS, DIALOG, DROLS, NASA/RECON, and ORBIT into the format specified by the user. In addition, DGIS provides access to an electronic mail module through the Internet and DDN system.

SearchMAESTRO (Menu-Aided Easy Searching Through Relevant Options) is designed to help novice users conduct their own online database research. End users may easily access 13 different online systems with more than 850 total databases by using this menu-driven system. SearchMAESTRO will even select the appropriate database for a given search strategy if one is not otherwise indicated. In addition, there is no need for separate accounts with each database vendor; even if the user searches all 850 databases available to SearchMAESTRO, there is only one bill.

For more information call Ms. Patricia Tillary

on (703) 274-6434 or DSN 284-6434 or write to: Defense Technical Information Center, DGIS/SearchMAESTRO Information, Cameron Station, Building 5, Alexandria, VA 22304-6145

### Certification for Ergonomists and Human Factors Professionals



The Board of Certification in Professional Ergonomics is now accepting applications for professional certification of ergonomics and human factors practitioners. Applicants should have a mastery of ergonomics knowledge and methods, as well as expertise in the analysis, design, and evaluation of products, systems, and environments for human use. Qualified applicants may choose to be certified as either Certified Professional Ergonomists (CPE) or as Certified Human Factors Professionals (CHFP). Applications are available from: Board of Certification in Professional Ergonomics, Office of the Executive Director, P. O. Box 2811, Bellingham, WA 98227-2811 USA; (206) 671-7601, fax: (206) 671-7681.

Minimum qualifications are an MA/MS or equivalent in ergonomics or a closely related field and 7 years of demonstrable experience in the practice of ergonomics. Applications are open to ergonomists internationally.

Certification will be based on an evaluation of work samples and supporting documentation through December 31, 1993. The application processing fee is US \$200 (nonrefundable) with an annual renewal fee of \$75. After December 31, 1993, applicants will be required to pass a written examination.

The Board of Certification in Professional

Ergonomics was formed as a nonprofit corporation in 1990. Although the Board was established with support from the Human Factors Society, it is independent of any professional, scientific, or trade association.

Current members of the Board are Alphonse Chapanis, Ph.D.; David Meister, Ph.D.; Melvin H. Rudov, Ph.D.; Hal W. Hendrick, Ph.D.; George A. Peters, J. D.; H. Harvey Cohen, Ph.D.; David J. Cochran, Ph.D.; Jerry R. Duncan, Ph.D.; Steven M. Casey, Ph.D. The Executive Director is Dieter W. Jahns, M.S.

### Human Systems Integration (HSI) Software Fair

Open to all members of the DoD Human Factors Engineering Technical Group (DoD-HFE-TG). Government-owned microcomputer-based tools addressing any or all of the HSI elements. Exhibited software must be available for distribution free of charge to other US government agencies. Please, no classified software.

The fair will be held November 4, 1992, in conjunction with the DoD-HFE-TG Meeting. The location for the meeting and the fair is Holiday Inn, Research Park Ballroom, Huntsville, AL. The hours for the fair will be 6:30-10:00 PM.

Please contact CAPT Donald Loose, CSTI/PIAT, Wright-Patterson AFB, OH 45433-5000; (513) 255-3871, DSN 785-3871.

### Industrial Ergonomics Bibliography

The Human Factors Society has revised its guide to the literature on industrial ergonomics, "Industrial Ergonomics Bibliography." The new brochure is free of charge and lists publications that contain data useful for the design of jobs in industry.

The bibliography is divided into six sections, *Continued on page 8*

# GATEWAY

in addition to lists of periodicals and proceedings: *General* lists texts and handbooks; *Worker Characteristics* covers size, strength, age, and gender; *Job Design* addresses productivity, human error, fatigue, and accidents; *Equipment Design* concerns displays, controls, and tools; *Workplace Design* includes information on chairs, benches, floors, and stairs; and *Environmental Design* covers heat, noise, vibration, and illumination.

The bibliography is designed for human factors practitioners, industrial engineers, safety professionals, occupational physicians and nurses, industrial hygienists, personnel specialists, managers, labor union officials, and workers.

To obtain a free copy of the "Industrial Ergonomics Bibliography," contact the Human Factors Society, P.O. Box 1369, Santa Monica, CA 90406-1369; (310) 394-1811, fax (310) 394-2410.

## Liveware Survey & Database Progress



The Liveware survey, sponsored by OASD (FM&P)/R&R (TFR) Human System Integration Office has received many interesting responses describing manpower, personnel, training, safety, health hazard, human factors engineering, and human system integration (HSI) tools. This NATO-wide survey will be analyzed by members of NATO Research Study Group RSG.21 to identify under-represented technologies and set research priorities, as well as to share information about HSI technology.

As of September 30, 1992 the surveys received have reported contributing to one or more of the following areas:

Area	Number Addressing
MANPOWER	76
PERSONNEL	70
TRAINING	149
<i>(43 Covering M,P, &amp;T)</i>	
SAFETY	35
HEALTH HAZARDS	28
HUMAN FACTORS	
ENGINEERING	68
INTEGRATION	49
<i>(of 2 or more of the above categories)</i>	

Since the initial article in the March/April 1992 *Gateway*, respondents have requested clarification of the type of technologies being sought. To answer this request, the focus of the Liveware survey is to capture the technologies that can permit better consideration and integration of the human in defense systems. Technologies are defined as:

- Methods, techniques, guides, MIL-STDs, MIL-HDBKs, critical information sources;
- Databases;
- Tools, models (computerized or not), wargames;
- Training development and presentation systems/methods;
- Data collection systems, tests, test facilities, test methodologies, test equipment; and
- Human system systems and human system support systems which facilitate integration of humans into the defense system and the environments in which they must operate.

The technology can be automated, non-automated, procedural guides, databases, or other critical information sources which can help ensure that humans or human issues are effectively integrated into defense systems during the acquisition process.

The first demonstration of the Liveware database will take place at the DoD Human Factors Engineering Technical Group's semi-annual meeting, November 2-6, 1992 at Huntsville, AL, at the Technical Group's software fair.

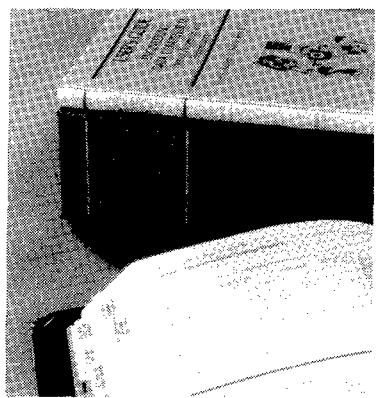
While the Liveware survey has received over 260 responses, there appear to be many human factors and other HSI technology owner/developers who have not yet participated. Lt Col Mike Pearce, Chief of the OASD(FM&P) HSI office and Chair of NATO RSG.21, urges you to participate in the survey.

Note the new address for Dr. Crissey. As the Defense Training and Performance Data Center closes, she is continuing the project at the U.S. Army Research Lab's field office at the Simulation, Training, and Instrumentation Command (STRICOM).

To obtain a survey or further information, contact: Director, U.S. Army Research Laboratory, Human Research and Engineering Directorate, STRICOM Field Element, Attn: AMSRL-HR-MT (Dr. Mona Crissey), 12350 Research Parkway, Orlando, FL 32826-3276; (407) 380-4356, DSN: 960-4356, FAX: (407) 381-8697. She is the Liveware Project Manager.

Frank C. Gentner, AL/CFH/CSERIAC, Wright-Patterson AFB, OH 45433-6573; (513) 255-4842, DSN: 785-4842, FAX: (513) 255-4823, E-Mail: FGentner@Falcon.AAMRL.AF.MIL. He is the CSERIAC Senior Technical Analyst assisting in this study.

## AN ERGONOMIC APPROACH TO ERGONOMIC DATA



*Engineering Data Compendium: Human Perception and Performance* edited by Kenneth R. Boff and Janet E. Lincoln (1988)

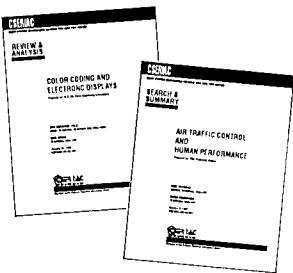
**E**ngineering Data Compendium: *Human Perception and Performance* is a landmark human engineering reference for system designers who need an easily accessible and reliable source of human performance data. Editors Kenneth R. Boff and Janet E. Lincoln make understanding, interpreting, and applying technical information easy through their innovative format. This four volume, 2758 page set features nearly 2000 figures, tables, and illustrations in several well structured approaches for accessing information. Brief encyclopedia-type entries present information about basic human performance data, human perceptual phenomena, models and quantitative laws, and principles and nonquantitative laws. Section introductions provide an overview of topical areas. Background information and tutorials help users understand and evaluate the material.

For further information on the *Engineering Data Compendium*, contact:

CSERIAC Program Office  
AL/CFH/CSERIAC  
Wright-Patterson AFB, OH 45433-6573  
Commercial: (513) 255-4842  
Fax: (513) 255-4823  
Autovon: 785-4842  
Fax: 785-4823



## CSERIAC TECHNICAL SUMMARY AND ANALYSIS SERVICES



### What is a Technical Inquiry?

Simply stated, a technical inquiry is a request for ergonomics information. In general, ergonomics information is technical knowledge about human abilities and performance, which can be used to enhance equipment design and development.

CSERIAC's answer to inquiries can take many forms, including customized bibliographic searches, review and analysis of research, recommendations based on analyses, and expert consultation referrals. We have grouped these into three basic categories, based on the kind and amount of ergonomics expertise applied to the problem. The three categories are Search and Summary, Review and Analysis, and Technical Area Tasks. A fixed fee has been established for the first two; Technical Area Tasks must be negotiated on an individual basis.

### Search and Summary

Search and Summary consists of a literature search and a print-out of relevant abstracts, which are then bound in a booklet. A professional human factors ana-

lyst reviews the abstracts and identifies the most pertinent. The human factors analyst also consults references within CSERIAC's immediately accessible resources and provides comments and/or excerpts from these references. The main purpose of this level of response is to provide a very rapid response to requests for technical information.

### Review and Analysis

This level of response includes all of the above plus direct contact with subject-matter experts, a 3-to-7 page white paper synthesizing the results of the technical review, complete copies and/or excerpts from relevant documents, and names, addresses, and telephone numbers of subject-matter experts. It also includes the requisite materials for access to data-

bases and personal contact with the subject-matter experts. The main purpose of this level of response is the in-depth synthesis of the literature with the formation of an authoritative "conclusion" or answer regarding the question posed.

### Technical Area Tasks

In this category are those inquiries requiring major CSERIAC time and material expenditures, such as preparation of state-of-the-art reports (SOARs), critical reviews, technical assessments, and handbooks, organizing workshops and symposia, or exercising computer models in our technology transfer inventory. The main purpose of this level of response is an extensive customized effort directed at solving the customer's particular needs.

### Previous Topics

- Pilot Decision-Making Under Stress
- Speech Synthesis and Recognition
- Human Tolerances to Impact
- Operator Workload Assessment: Subjective Techniques
- Design Guidelines for Human-Computer Interaction
- Cumulative Trauma Disorders in the Workplace
- Shift Work and Sleep Deprivation
- Human Error
- International Anthropometric Data Sources
- Color Coding and Visual Displays



### Previous Customers

- NASA
- General Motors Corporation
- AT&T Bell Laboratories
- US Army Tank-Automotive Command
- University of Illinois
- Texas Instruments Inc.
- US Consumer Product Safety Commission
- NCR Corporation
- Naval Air Warfare Center
- Ford Motor Company
- FAA Technical Center
- US Nuclear Regulatory Commission

For More Information Contact:  
Mike Gravelle  
Senior Technical Analyst  
CSERIAC Program Office  
(513) 255-4842

## Armstrong Laboratory Colloquium Series A Short History of Human-Computer Interaction

Brian Shackel

*Editor's note: Following is an abstract based on Professor Shackel's presentation as the fourth speaker in the Armstrong Laboratory Colloquium Series: The Human-Computer Interface. Dr. Sarah Swierenga, a Human Factors Engineer with Mead Data Central, Dayton, OH prepared this abstract.*

**T**he interdisciplinary field of human-computer interaction (HCI) can be understood through three levels as seen in the figure. The "Human-Machine Interface" matches human capabilities and limitations to components of the technical system, i.e., task properties, environmental constraints, technical design issues, and evaluation methodologies. The "Human-Computer Interface" identifies human-computer partnerships formed to support complex task performance. At this level, task analysis, knowledge elicitation, and user modeling techniques are used to design more effective decision support systems, computer conferencing systems, or computer-aided design systems. The most global layer, the "Organizational-System Interface," describes how multi-user human systems interact with complex technical systems, e.g., how organizational structures and roles affect team building and how automation impacts the quality of working life.

Within this framework, I would like to describe the growth of computer use and the advancements in computing technology. In the late 1950s, the potential for the computer in industry and commerce was recognized, and business machines were

developed by computer specialists for use by data processing professionals. From the mid 1960s, the minicomputer and remote terminal access to the time-sharing mainframe brought computer usage nearer to the non-specialist. The advent of the microcomputer in 1978 significantly increased the use of computers for many different purposes by many types of users. The widely diversified user community highlighted a multitude of user interface problems. The information technology industry realized the necessity of improving the usability of interactive systems to be competitive in the marketplace. Thus, the human factors aspects of the computer interface have become a very important design consideration.

My 1959 paper in *Design*, "Ergonomics for a computer," has been reported as the first to appear in the HCI archival literature. In the following year, Licklider (1960) wrote a seminal, prophetic paper, "Man-computer symbiosis," wherein he described the increasing interdependencies that he envisioned would grow between man and computer.

Most of the subsequent early literature focused on military systems. The work done on HCI during the 1960s was sporadic, focusing on hardware issues, large systems, and process control rather than on office and business systems. The end of the decade was marked by the first international meeting, held in 1969 in Cambridge, UK. The first journal for the HCI-related research appeared in the same year, the *International*

*Journal of Man-Machine Studies.*

In the early part of the 1970s, four important books were published which were influential in attracting attention to ergonomics issues: Sackman (*Man-Computer Problem Solving*, 1970) examined existing empirical studies of problem solving with the aid of computers; Weinberg (*The Psychology of Computer Programming*, 1971) mapped the range of psychological issues involved in computer programming; Winograd (*Understanding Natural Language*, 1972) addressed the issues associated with programming machines to respond to human natural language; and Martin (*Design of Man-Computer Dialogues*, 1973) provided considerable advice from practical experience to aid the design of better human-computer dialogues with mainframes. And in 1970, two centers were established which have made significant contributions to the field of HCI: The Human Sciences and Advanced Technology (HUSAT) Group, and Xerox's Palo Alto Research Center (PARC). HUSAT has played a leading role in applying human factors data to computer design and use. PARC's mission was to provide research support for Xerox's entry into the business of digital office technologies and systems. Artificial intelligence has been another fundamental part of the work at PARC.

At the beginning of the 1980s, five major books were published which defined the range of work on specific issues. Shneiderman (*Software Psychology: Human Factors in Computer and Information Systems*, 1980) out-

# GATEWAY

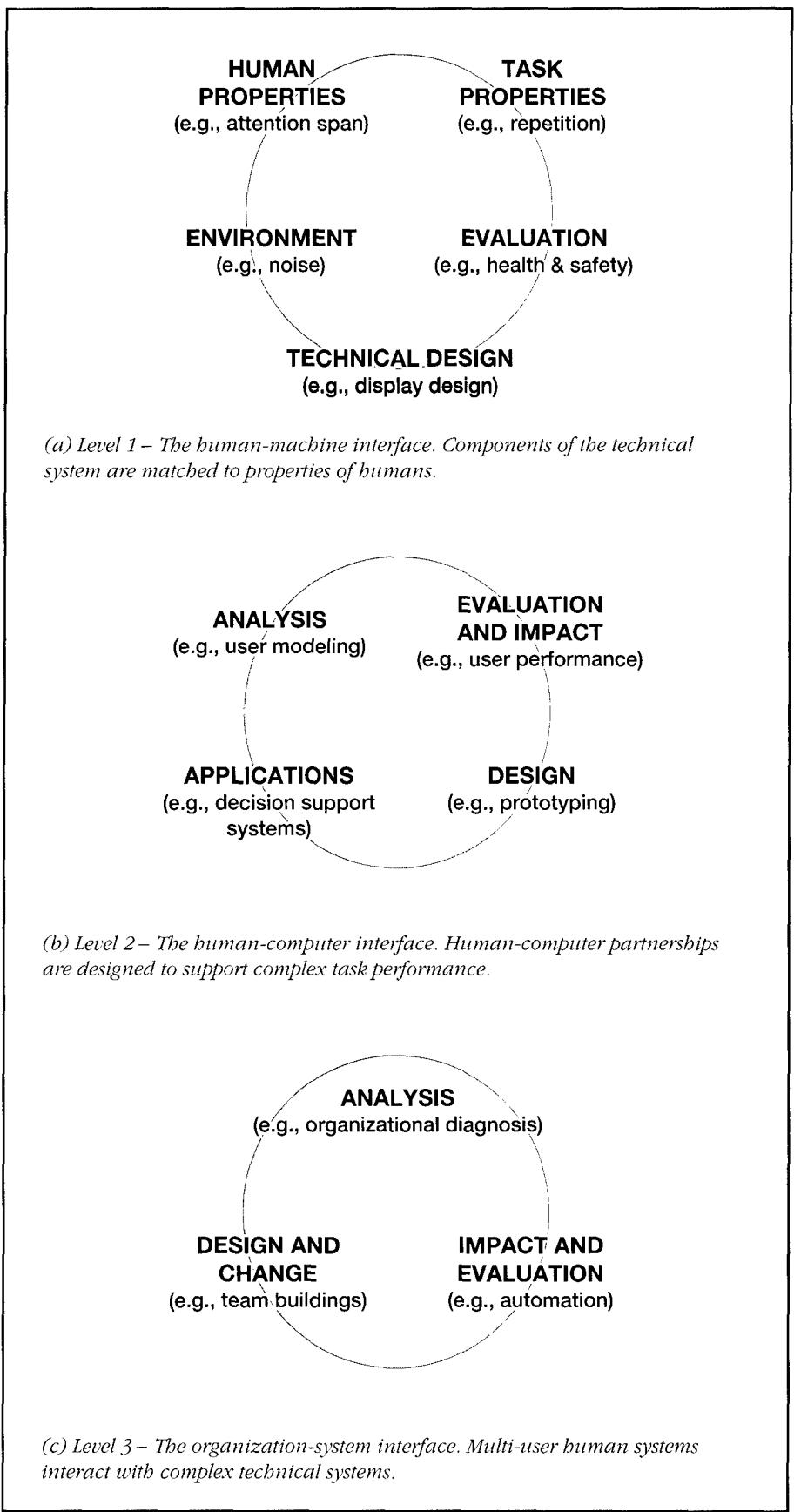
lined the actual and potential contributions from psychology to computing. Smith & Green (*Human Interaction with Computers*, 1980) edited a volume of empirical research on HCI. Cakir, Hart, and Stewart (*Visual Display Terminals*, 1980) and Damodaran, Simpson, and Wilson (*Designing Systems for People*, 1980) presented the first human factors handbooks for HCI. The fifth was *Ergonomics Aspects of Display Terminals*, a book containing the papers from the first conference on the ergonomic aspects of visual display terminals edited by Grandjean and Vigliani (1980). In addition, throughout the 1980s, there was a tremendous growth in the number of conferences and meetings on various aspects of HCI. The growth in journals, books, and special interest groups showed the same trend.

Currently, the emphasis of HCI efforts is on technology transfer, that is, applying human factors research to real-world systems. As a result, research and development projects are focusing on integrated applications such as computer-supported cooperative work, multimedia systems, neural networks, virtual reality systems, home information technology systems, and advanced manufacturing technology. By extensive studies aimed at understanding and modeling better interactive systems, we can envision the possibility of Licklider's human-computer symbiosis coming much closer to reality. ●

*Brian Shackel is Professor of Ergonomics and Director of the Human Sciences and Advanced Technology Research Institute (HUSAT) at the Loughborough University of Technology, Loughborough, UK.*

## References

Cakir, A., Hart, D. J., & Stewart, T. F. M.  
*Continued on page 12*



*The three levels of human-computer interaction.*

(1980). *Visual display terminals*. Chichester, UK: Wiley.

Damodaran, L., Simpson, A., & Wilson, P. (1980). *Designing systems for people*. Manchester, UK: National Computing Centre.

Grandjean, E., & Vigliani, A. (1980). *Ergonomics aspects of display terminals*. London: Taylor & Francis.

Licklider, J. C. R. (1960). Man-computer symbiosis. *IRE Transactions on Human Factors in Electronics, HFE-1*, 4-11.

Martin, J. (1973). *Design of man-computer dialogues*. Englewood Cliffs, NJ: Prentice-Hall.

Sackman, H. (1970). *Man-computer problem solving*. Princeton, NJ: Auerbach.

Shackel, B. (1959). Ergonomics for a computer. *Design*, 129, 36-39.

Shneiderman, B. (1980). *Software psychology: Human factors in computer and information systems*. Cambridge, MA: Winthrop.

Smith, H. T., & Green, T. R. (Eds.). (1980). *Human interaction with computers*. London: Academic Press.

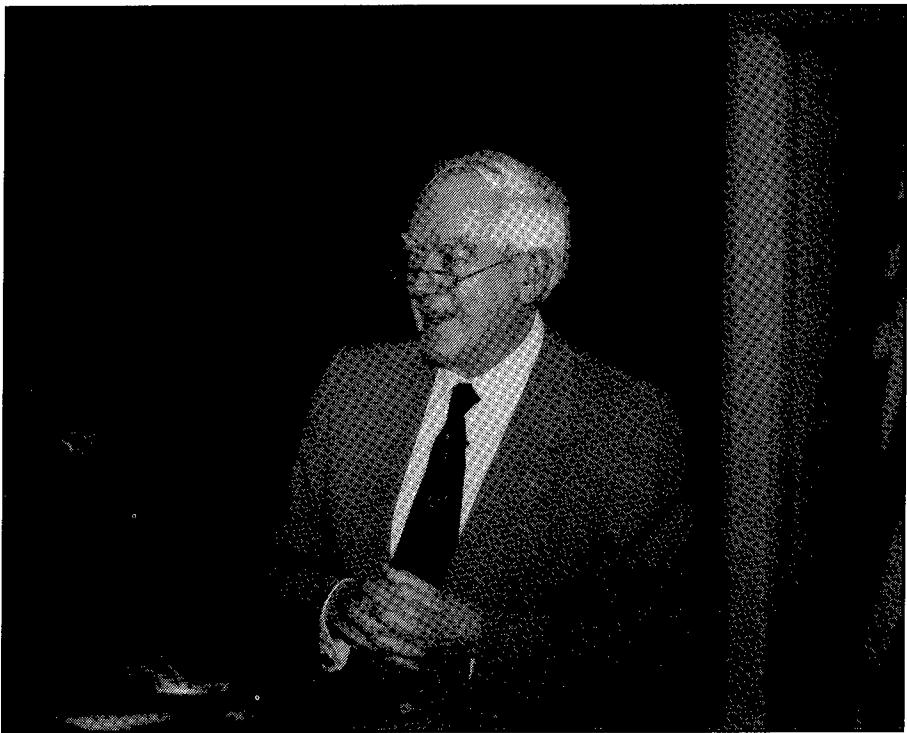
Weinberg, G. M. (1971). *The psychology of computer programming*. New York: VanNostrand Reinhold.

Winograd, T. (1972). *Understanding natural language*. Edinburgh, Scotland: The University Press.

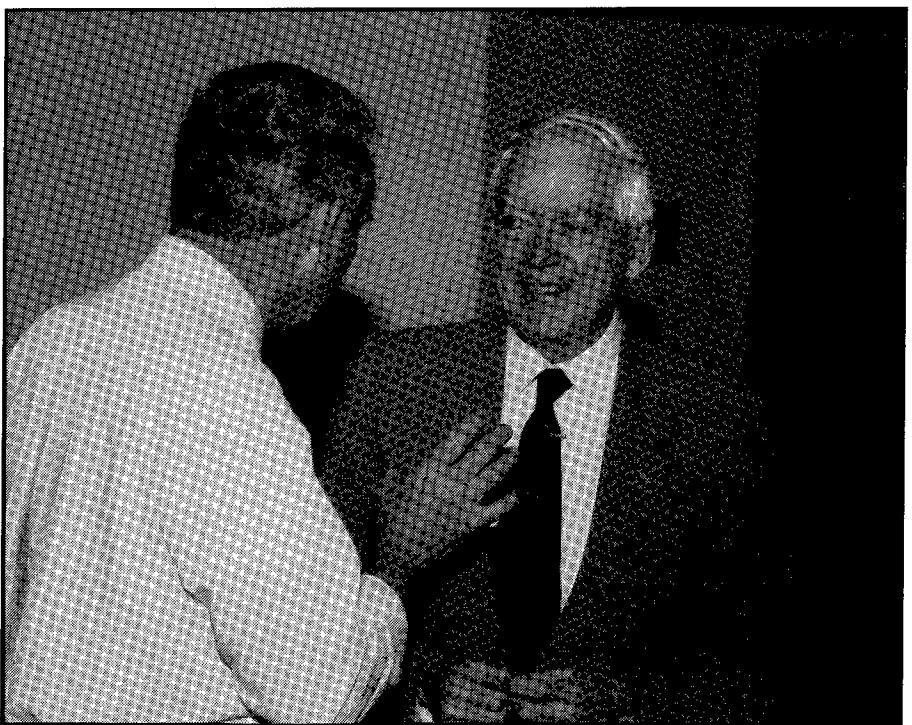
### **Professor Shackel's presentation was based on the following article:**

Shackel, B. (1991). Whence and where: A short history of human-computer interaction. In H. J. Bullinger (Ed.), *Human aspects in computing: Design and use of interactive systems and work with terminals* (pp. 4-18). Amsterdam: Elsevier.

### *Scenes from the Armstrong Laboratory Colloquium Series:*



*Professor Shackel talking about the influences of ergonomics, cognitive psychology, graphics design, and software engineering on human-computer interaction.*



*Professor Shackel answering questions from attendees following the lecture.*

## Human Factors in the Federal Aviation Administration (FAA)

Mark A. Hofmann

**H**uman factors in the FAA is well and getting better! This technology area is moving quickly because four critical elements have come together to bring unprecedented support: management awareness and participation in the mid to late 1980s; the Congressional Office of Technology Report of 1988 entitled *Safe Skies for Tomorrow: Aviation Safety in a Competitive Environment*; the Aviation Safety Research Act of 1988 (PL 100-591); and the *National Plan for Aviation Human Factors*, published in November 1990.

Numerous human-factors-related activities are occurring in the FAA which support two primary areas of endeavor. One area involves human factors or performance research required by the National Airspace System (NAS) and the other involves technology transfer of the application of research results to the System. The research portion of the endeavor is now, among other places, articulated

in the *National Plan for Aviation Human Factors* (see fig.).

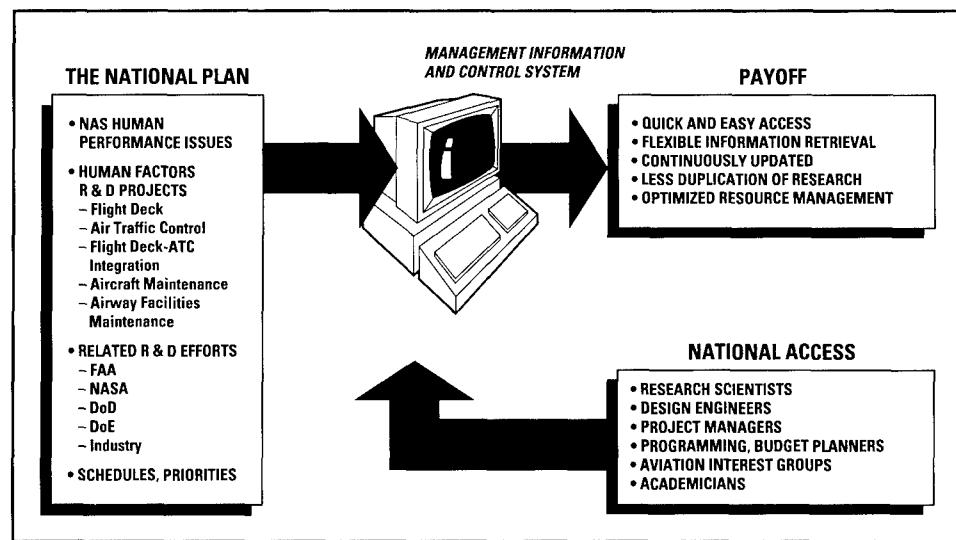
The plan divides the research into the five major environmental categories of flight deck, air traffic control, flight deck/air traffic control integration, aircraft maintenance, and airway facilities maintenance. The plan was formulated and continues to be updated as a partnership effort between the FAA, National Aeronautics and Space Administration (NASA), Department of Defense (DoD), and a wide array of aviation-interested industries, professional groups, and academic institutions. The plan, among other things, addresses and prioritizes ongoing, important human factors research. Therefore, it serves as a research roadmap as well as an overall coordination mechanism for those performing and those interested in aviation-related research.

Within the plan, the FAA has a number of ongoing research efforts across the five environments of inter-

est. This research is being performed by the FAA Technical Center in New Jersey, Civil Aeromedical Institute (CAMI) in Oklahoma City, and various FAA, commercial, and academic contractors throughout the United States. The plan is maintained by the FAA and will soon be resident in a relational data base. This relational data base will permit more efficient access, update, and reporting capabilities.

Direction for the plan is provided by the Human Factors Coordinating Committee within the FAA, and by a Human Factors Technical Advisory Group within the NASA-FAA Coordinating Committee. Industry and academic input is continually provided by several professional groups which include the Human Factors Society and the Air Transport Association's (ATA) Human Factors Task Force. The ATA Task Force has participating membership from NASA, FAA, National Transportation Safety Board, pilot and contractor unions,

*Continued on page 14*



*The National Plan serves as a research roadmap and coordination mechanism for those performing and those interested in aviation-related research.*

# GATEWAY

airframe and parts manufacturers, as well as the major airlines.

With respect to the application of human factors throughout the NAS, the FAA is taking a very aggressive and proactive approach. It plans, for example, to add more human factors expertise to its workforce to enhance human factors technology transfer to its procedures and processes. A Quality Action Team has been established under the FAA Total Quality Management Program for the explicit purpose of examining how the application of human factors has been institutionalized with respect to all phases of the material acquisition and improvement process.

To assist in the accomplishment of activities within these two primary areas of endeavor, and to ensure that human factors is an integral and visible part of the FAA, a Scientific and Technical Office for Human Factors has been established within the office of the Executive Director for System Development. This office serves as the FAA human factors focal point and

provides subject-matter expertise across the five National Plan environments. It provides leadership for the FAA-chartered Human Factors Coordinating Committee, and will ensure that FAA human factors research is coordinated across the agency and is appropriately represented in the FAA Research, Engineering, and Development (RE&D) Plan. It will also ensure that FAA RE&D coordinates with NASA and DoD to most effectively implement the National Plan. In addition, it is charged with ensuring that FAA human factors research needs and results are applied to FAA processes and made known to the aviation community at large.

Clearly, the FAA is committed to human factors as part of its overall strategy to continuously enhance the safety, efficiency, and capacity of this Nation's airspace system. ●

*Mark A. Hofmann, Ph.D., is a staff member of the Scientific and Technical Advisor Office for Human Factors, Federal Aviation Administration, Washington, DC.*

## Request for Topics

### For State-of-the-Art-Reports (SOARS)

CSERIAC makes every effort to be sensitive to the needs of its users. Therefore, we are asking you to suggest possible topics for future SOARS that would be of value to the Human Factors/Ergonomics community. Previous SOARs have included *Hypertext: Prospects and Problems for Crew System Design* by Robert J. Glushko, and *Three Dimensional Displays: Perception, Implication, Applications* by Christopher D. Wickens, Steven Todd, & Karen Seidler. Your input would be greatly appreciated. We are also looking for sponsors of future SOARS. CSERIAC is a contractually convenient, cost effective means to produce rapid authoritative reports.

Send your suggestions and other replies to Dr. Lawrence Howell, Associate Director CSERIAC Program Office, AL/CFH/CSERIAC, Wright-Patterson AFB, OH 45433-6573.

# CONFERENCES MADE EASY



*Up-to-date information for those who need it*

**S**implify your life by letting CSERIAC manage your next conference, workshop, or symposium. We offer great flexibility as we can manage an event anywhere and handle all the details, from start to finish. We will select the best site, order coffee breaks and meals, reserve audio-visual equipment, prepare course notebooks, arrange for overnight accommodations, design and print your invitations and announcements, invite your guest speakers, arrange for press coverage, and publish the proceedings. There is no need to use multiple organizations to manage your event.

*For further information on using these conference administration services, contact:*

CSERIAC Program Office  
AL/CFH/CSERIAC  
Wright-Patterson AFB, OH 45433-6573  
Commercial (513) 255-4842  
Fax: (513) 255-4823

Autovon: 785-4842  
Fax: 785-4823



## Issues in Head-Up Display Design: The Book of HUD

Daniel J. Weintraub

**H**ead-up displays (HUDs) for tactical military aircraft are standard equipment. HUDs for automobiles can be spotted in TV commercials, and are available as options. Is the lure of fighter-aircraft technology through your own auto windshield, symbols dancing transparently out of reach in front of the eyes, irresistible? Are HUDs useful? Are they safe?

CSERIAC perceived the need for a head-up display state-of-the-art report (SOAR) and this article reviews the development of that report. A HUD is a virtual-image display in which the symbology appears to be located at some point beyond the cockpit, cab, or workstation. In this report, aircraft and automotive HUDs are covered, with the accent on aircraft, since much of the HUD research is concentrated here.

Breaking out of a low overcast on an instrument approach to a landing, when will the pilot spot the unauthorized aircraft on the duty runway? Similarly, when will a driver notice the child darting into a city street? HUDs can have an impact on such situations as they eliminate the need to scan instrument panels, saving head-down time, time to shift the gaze down and up, and time to refocus the eyes (from near to far is especially slow). How can HUDs not be useful and safe? Well, for starters, HUDs, by being optically projected into the environment, clutter the center of the operator's field of view especially at night. This, in itself, can cause accidents.

The advice of experts and the logic of HUDs were used to generate important issues and questions, like those above. Logic and expert opinion were scrutinized in the light of research findings, which were relied upon heavily. (The extent to which labora-

tory and simulator studies apply to real-world HUD use is an important issue.) Research, defined broadly, went far beyond searching the HUD literature; it even went into eye mechanisms and visual illusions.

In full high-fidelity simulations with high-flight-time pilots (and big budgets) conventional instrument panels have been pitted against HUDs. HUD advantages generally turn out to be small, and few achieve statistical significance. But there are salient experiments that show a strong HUD superiority effect (for instrument-landing symbology). Sensitive measures of pilot performance at crucial points in the approach, and a wide variation in weather degradation are the keys.

Diagnostic evidence in precise detail about the good and bad features of HUDs is needed for the design of future generations of displays. That HUDs impede recovery from unusual aircraft attitudes is a documented problem; the solutions are not so clear. Stanley Roscoe's arguments that collimated HUD symbology (HUD symbols appearing optically at infinity) distorts size/distance perception is considered carefully from different perspectives and found wanting.

Nuts and bolts issues are covered, such as parameters affecting symbol legibility: luminance, size, stroke width, color advantages and disadvantages.

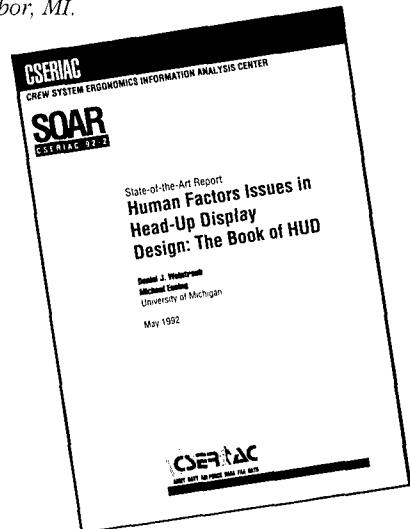
Cognitive issues are discussed as well. Symbol integration is an important one. True, reproducing a dial face, gauge, or digital readout electronically on the HUD clusters the information, thereby curtailing eye movements. Packaging symbology to be easily perceived and compatible with the way humans process information is the goal. Cognitive capture is a potential problem as HUD symbology may be so

compelling that the observer cannot easily switch attention from the symbology to the environmental scene viewed simultaneously. Cognitive-capture research is difficult; the evidence is sparse but suggestive. Novel HUD applications are described, including an automobile system that permits driving and TV watching simultaneously. Since the driver's eyes never stray very far from the road ahead, this is perhaps the ultimate test for cognitive capture.

The report concludes with a proposal, the DUET display (Down-Up Electrosymbology Twins), intended to incorporate the best features of head-up and head-down displays. Trails of evidence were followed wherever they led. Interesting evidence and leads for fruitful research were uncovered. Our goal was not to press a point of view, but to bring together information and evaluation that assist readers in sharpening their own.

Copies of the HUD SOAR are available through the CSERIAC Program Office for \$35. ●

*Dan Weintraub, Ph.D., is Professor of Psychology, University of Michigan, Ann Arbor, MI.*



## Overview, Observations, & Reactions

Aaron W. "Ron" Schopper

**T**his is the first rendering of what we at CSERIAC envision as a continuing column to provide comments and observations regarding CSERIAC-attended colloquia, symposia, conferences, etc., occurring within the human factors/ergonomics community. The "Overview, Observations" portion of the above title was selected to reflect the fact that a page or so will never be able to adequately reflect the content or theme of any given event. Because a single individual cannot possibly attend all presentations within larger conferences and meetings, there will always be holes in the coverage. Given the enormous breadth of topics covered under the umbrella of the terms "human factors" and "ergonomics," the CSERIAC staff will always be vulnerable to the charge that we missed an event or presentation that someone considered very important (leading him or her, perhaps, to more aggressively assert that the title of the column should be "Oversight & Ignorance"). We acknowledge that risk and have decided to push forward, regardless.

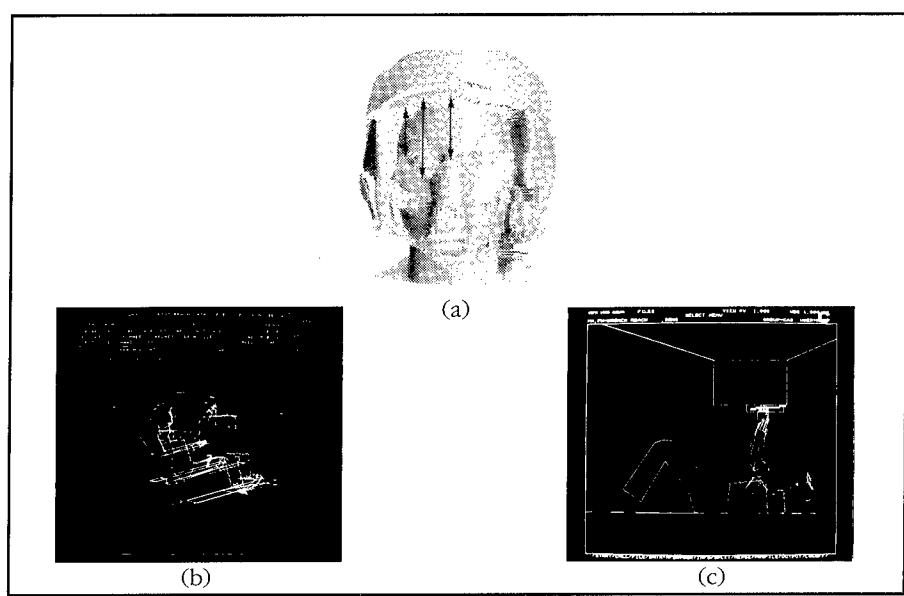
The last word of the title, "Reactions," is intended to invite readers to communicate their own observations and comments. While the use of this term suggests that a reader's comments must (or should) respond to something appearing within a previous column, that is not the case. Because it is CSERIAC's goal to facilitate the communication of important human factors information and issues, we encourage efforts to complement and supplement the information we provide. And, while the intent is not to provide a forum for extended debates, we will gladly receive reader commentary regarding significant issues and will attempt to provide such space as may be available to air them to the *Gateway* readership.

And, last, the choice of an ampersand within the title was deliberate, for the comments and observations presented will tend to be low key and quite unofficial in nature.

Because CSERIAC is a Department of Defense/Defense Technical Information Center (DoD/DTIC) organization, it is appropriate that this initial column be devoted to the Department of Defense Human Factors Engineering Technical Group (DoDHFETG) meeting held in New Orleans early in May of this year. (In a future column, I hope to provide a brief historical account of the evolution and function of the Technical Group.) The event was hosted by the US Naval Biodynamics Research Laboratory. While the attendance wasn't quite up to previous levels, reflecting, no doubt, the impact of current DoD downsizing activities, the mood of the attendees did not appear to be adversely affected. As usual, most presentations were well prepared and upbeat, reflecting the "we can (will) do more with less" theme that has become increasingly commonplace within the DoD.

For those not familiar with the DoDHFETG meetings, the content of the various presentations varies widely, as do the affiliations of the presenters. The presentations in New Orleans ranged from major program overviews of the type provided by Dr. Maris Vikmanis regarding the ongoing efforts (e.g., the development of 3-D head and face data bases, and COMBIMAN and CREW CHIEF Computer-aided Engineering models; see fig.) of the Human Engineering Division, Armstrong Laboratory, Wright-Patterson Air Force Base, OH, to presentations that focused on a single research effort, e.g., that by Dr. Diane Williams of the Naval Health Research Center, San Diego, CA, which reported the cognitive performance of sleep-deprived marines who wore MOPP gear (chemical defense clothing) ensembles for 36 hours.

An increasingly common theme in the New Orleans presentations related to the oft-espoused, venerable need for increased interoperability and standardization. Dr. Robert Fleming, Naval



The development of (a) 3-D head and face databases, (b) COMBIMAN, and (c) CREWCHIEF are part of the mission of the Human Engineering Division of Armstrong Laboratory.

# GATEWAY

Command, Control, and Ocean Surveillance Center (NCCOSC), Navy RDT&E Div, San Diego, CA, reported on an action emanating from a common operating environment (COE) subgroup formed after Desert Storm to address needs within the human-computer interface area. He stated that the DoD Intelligence Information Systems (DODIIS) guide was selected to serve as a style guide. It was released as a Defense Information Systems Agency (DISA) document via its Center for Information Management (CIM) in February 1992. Albeit very general in nature, it dictates the use of X-Windows as the window management software and either *Motif*<sup>™</sup> or *Open Look*<sup>™</sup> as the graphical user interface. The document also includes an 83-page appendix of human factors guidelines taken primarily from an Army source.

In other areas, as well, the need for greater commonality was evident. LT David Street, Naval Aeromedical Research Laboratory, Pensacola, FL, summarized the tri-service efforts to develop, validate, and manage a common selection battery that resulted in a recommendation to use the Air Force's Basic Attributes Test (BAT) as the common hardware testing base for all services. Dr. Schiffler, of the Aeronautical System Center, Wright-Patterson AFB, OH, addressed the compelling need for commonality and standardization of symbologies used in cockpit displays. Irrespective of issues pertaining to design and development costs, the benefits of such commonalities have marked implications for transfer-of-training and safety considerations. He focused on the work being done in support of the Air Force's MIL STD 1787, emphasizing the acute need in the area of head-up displays (HUDs). Research comparing HUD-only performance to head-down-display performance on a number of controlled tasks executed in F-16 and C-135 simulators was described; and plans for actual in-flight validation testing were cited.

The need for greater commonality among the services also was cited regarding the data bases among the various services' safety programs. In

two different sessions, the need was addressed in some detail and with some vigor during discussions led by William Mannschreck of the Naval Safety Center, Norfolk, VA. The matter has both retrospective and prospective aspects; i.e., the large, separate, already-existing data bases within each service (and the Coast Guard, Federal Aviation Administration, and National Aeronautics and Space Administration, too) should be integrated to provide greater user utility, and future coordinated efforts are needed to develop and implement common, reliable data collection procedures. (A basic science communication issue remains at the core of both of these matters; i.e., the absence of—and need for—a common taxonomy.) The topics of human error and safety investigation, and the need for standardization, automated data collection, and a centralized data base also were addressed by Ms. Clare Goodman of the Nuclear Regulatory Commission.

Dr. Jonathan Gluckman and Jeffrey Morrison described research relating to the Navy's Adaptive Function Allocation for Intelligent Cockpits (AFAIC) program. These researchers reported that during a dual-task assessment of representative flight conditions (concurrent pursuit tracking and a radar threat tactical target identification task), increases in the difficulty of the tasks resulted in poorer tracking performance—but no decrease in uniformly high target identification performance. They suggested that the differential impact of increased task difficulties on these two tasks may be related to the type and amount of feedback afforded the individuals during the execution of each task. They noted that the tracking task provides continuous feedback that becomes increasingly negative in nature as the level of difficulty increases (because increasingly poorer performance is readily apparent) and indicated that their findings may have implications for task-allocation-related decisions; i.e., the most difficult or least favorable tasks may be good candidates for adaptive allocation.

Progress in a recently initiated, high-visibility, short-term program within the Air Force targeted at coming to

grips with the critical—and somewhat elusive—concept of "situational awareness" (SA) was summarized by Dr. Mike Vidulich of the Human Engineering Division, Armstrong Laboratory, Wright-Patterson AFB, OH. Programmatic efforts to generate viable measures of SA, to identify potential tools to measure SA within the aviator-candidate pool, and to assess the extent to which SA capabilities can be enhanced via training are among the principal thrusts of the program.

There were several presentations pertaining to the Army's Health Hazard Assessment program chaired by LTC Jim Carroll, of the US Army Medical Research and Development Command, Ft. Detrick, MD. Dr. Carroll reviewed the Army's extensive program in this area and cited the need for greater tri-service integration. Within the same general area, but focusing on injury to the ear, Dr. Jim Patterson of the US Army Aeromedical Research Laboratory, Fort Rucker, AL, reviewed the history and current status of efforts associated with the development of standards for high-energy impulse noise. The topic relates primarily to the effects of rocket, missile, mortar, and artillery firing on military crews. While there are also potential whole-body effects (e.g., potential lung collapse associated with high overpressures), Dr. Patterson's presentation focused on the research related to the derivation of current hearing-related standards, citing both early animal studies and the more recent human tolerance studies conducted in field environments.

All-in-all, I viewed the DoDHFETG meeting as having provided another vital and successful opportunity to learn of, and appreciate, the considerable efforts undertaken within the DoD in the human factors/ergonomics arena. Given a reasonable period of time, I assure you that I'll make every effort to provide a balanced perspective of the DoDHFETG. Be patient, however, as it may take awhile—the DoDHFETG meets only twice a year. ●

*Ron Schopper, Ph.D., is the Chief of Technical Services and Analyses for the CSERIAC Program Office.*

## Defining Human Factors

Deborah Licht

*Editor's note: In the feature article, "Credentials, Criteria, and Certification of Ergonomists," Mr. Jahns makes reference to a paper on human factors definitions (Licht, Polzella, & Boff, 1991) produced by CSERIAC. Following is a reprint of an article on that paper from an earlier *Gateway* (Vol. I, No. 2). Copies of that paper are still available through the CSERIAC Program Office.*

**A**t the request of the Human Factors Committee of the National Research Council, CSERIAC analyzed existing definitions of *human factors* to aid the committee in establishing a standardized definition of the field. Although there are many definitions of *human factors*, a formally endorsed, unified definition does not exist.

CSERIAC compiled and analyzed definitions of *human factors* and related terms from a range of key reference sources and presented its findings to the committee to expedite its deliberations. Searches for appropriate resource materials were conducted at four area libraries using computerized catalogues. Definitions were extracted from 74 references, yielding a final sample of 90 verbatim definitions.

Many of the definitions had three components: the category (genus) of classification (e.g., field, discipline, profession, etc.); the domains of inclusion (e.g., biology, behavioral sciences, etc.); and the objectives (e.g., to increase system safety through application of human performance data in design). A standardized definition of *human factors* should probably incorporate all these components.

The definitions assembled for the analysis can be grouped into three general classes: *human factors*, *human factors engineering*, and *ergonomics*. The

table presents the categorization scheme that was used and the terms that were classified as synonymous. The *human factors* definitions in our sample are characterized by a broader category of classification and broader objectives. The *human factors engineering* definitions overwhelmingly emphasize design as the medium for effecting change in end systems. Definitions of *ergonomics* stress the study of humans at work.

These differences among the terms *human factors*, *human factors engineering*, and *ergonomics* must be considered in developing a single, unifying definition of the field.

Our analysis reveals a chronological trend towards broadening both the domains of inclusion and the objec-

tives of the human factors field. Originally, the focus of human factors was the design of military human-machine systems; this focus has expanded to include private industrial systems and consumer products as well. Thus the field has moved from a discipline born in a post-war, militarily oriented engineering environment to one active in a more global manufacturing and consumer-oriented environment.

A summary report of the analysis of human factors definitions may be obtained from the CSERIAC Program Office. ●

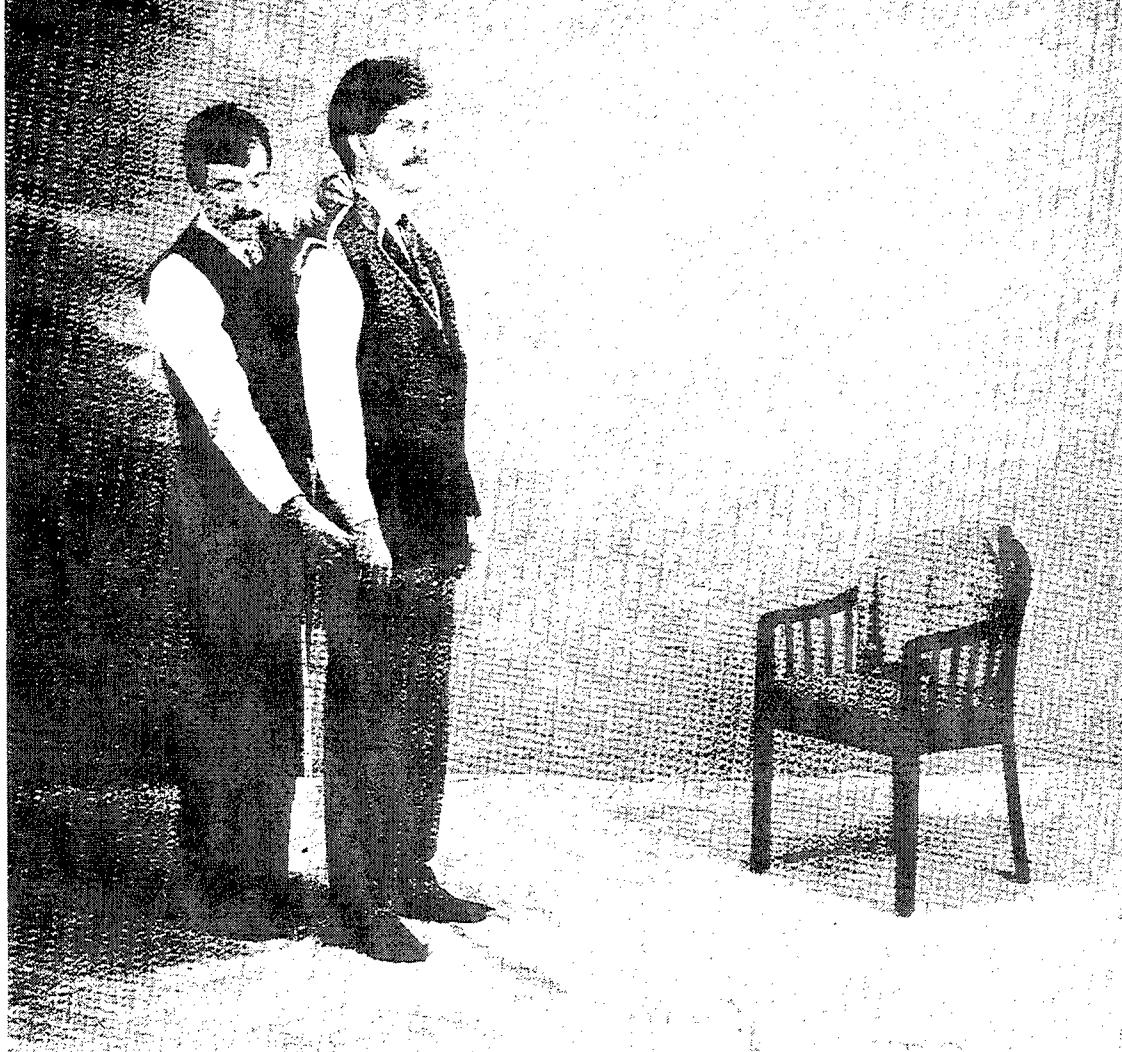
*Deb Licht, currently at Harvard University pursuing a doctoral degree, served as a Technical Analyst at CSERIAC and was the first Editor of *Gateway*.*

### Categorization of Synonymous Terms

HUMAN FACTORS ENGINEERING		18 <sup>a</sup> (.14) <sup>b</sup>
■ Anthropotechnics		1 (.01)
■ Applied Exp. Psychology		1 (.01)
■ Biomechanics		1 (.01)
■ Biotechnology		1 (.01)
■ Engineering Psychology		8 (.06)
■ Human Engineering		25 (.20)
■ Human Eng. Analysis		1 (.01)
■ Human Perf. Engineering		1 (.01)
■ Psychotechnology		2 (.02)
ERGONOMICS		31 (.25)
■ Applied Ergonomics		2 (.02)
■ Industrial Ergonomics		1 (.01)
HUMAN FACTORS		30 (.24)
■ Human Factors Psych.		1 (.01)
TOTAL		124

<sup>a</sup>frequency   <sup>b</sup>proportion

# THE PERFECT FIT!



## Tailored Answers to Human Factors Questions

There is certainly no lack of human factors data. It's everywhere. Your challenge is finding those pieces of information you need to solve your specific problem. The typical search doesn't work. Sifting through pages and pages of journal articles and document listings is time consuming and seldom produces really relevant citations. You need more than this simple "off-the-rack" solution. You need answers "tailored" to your unique human factors problems. CSERIAC can do this for you.

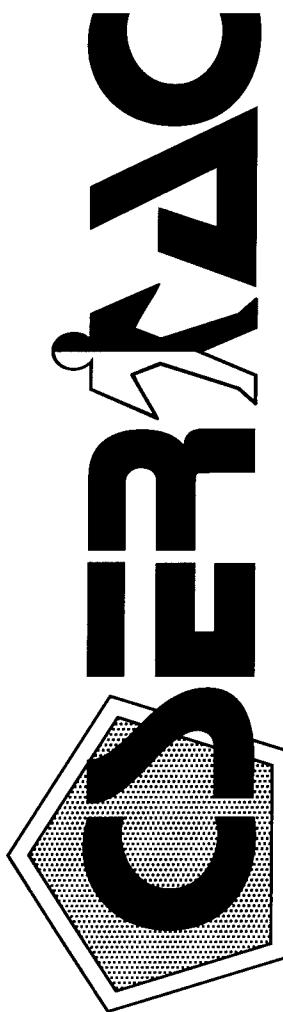
The Crew System Ergonomics Information Analysis Center (CSERIAC, for short) is your one-stop human factors technology "store." With one phone call, you can have your technical question answered, customized literature searches carried out, purchase state-of-the-art ergonomics software, or even have a human factors workshop planned and conducted for you.

Sound interesting? Call (513) 255-4842 today for more information!

### CSERIAC: Your Human Factors Technology Store.

CSERIAC Program Office  
AL/CPH/CSERIAC  
Wright-Patterson AFB, OH 45433-6573  
Tel: (513) 255-4842 Fax: (513) 255-4823  
DSN: 785-4842 DSN FAX: 785-4823





NEWS  
FROM the  
Defense Logistics Agency's

**CREW  
SYSTEM: CREDENTIALS, CRITERIA, AND CERTIFICATION OF ERGONOMISTS  
THE COTR SPEAKS**

**ERGONOMICS: CALENDAR  
INFORMATION: ANNOUNCEMENTS**

**ANALYSIS: A SHORT HISTORY OF HUMAN-  
COMPUTER INTERACTION**

**CENTER: HUMAN FACTORS IN THE FEDERAL AVIATION ADMINISTRATION  
OVERVIEW, OBSERVATIONS, & REACTIONS**

**DEFINING HUMAN FACTORS**

**AL/CFH/CSERIAC • WRIGHT-PATTERSON AIR FORCE BASE • OHIO 45433-6573**

Official Business • Penalty for Private Use \$300

Bulk Rate  
Postage & Fees Paid  
Defense Logistics Agency  
Permit No. G-53

## **CSERIAC PRODUCTS AND SERVICES**

CSERIAC's objective is to acquire, analyze, and disseminate timely information on crew system ergonomics (CSE). The domain of CSE includes scientific and technical knowledge and data concerning human characteristics, abilities, limitations, physiological needs, performance, body dimensions, biomechanical dynamics, strength, and tolerances. It also encompasses engineering and design data concerning equipment intended to be used, operated, or controlled by crew members.

CSERIAC's principal products and services include:

- technical advice and assistance;

- customized responses to bibliographic inquiries;
- written reviews and analyses in the form of state-of-the-art reports and technology assessments;
- reference resources such as handbooks and data books.

Within its established scope, CSERIAC also:

- organizes and conducts workshops, conferences, symposia, and short courses;
- manages the transfer of technological products between developers and users;
- performs special studies or task.

Services are provided on a cost-recovery basis. An initial inquiry to determine available data can be accommodated at no charge. Special tasks require approval by the Government Technical Manager.

To obtain further information or request services, contact:

CSERIAC Program Office  
AL/CFH/CSERIAC  
Wright-Patterson AFB, OH 45433-6573

Telephone ..... (513) 255-4842  
DSN ..... 785-4842  
Facsimile ..... (513) 255-4823  
Government  
Technical Manager ..... (513) 255-8821

*Associate Director:* Dr. Lawrence D. Howell; *Government Technical Manager:* Dr. Reuben L. Hann; *Government Technical Director:* Dr. Kenneth R. Boff.

CSERIAC *Gateway* is published bimonthly and distributed free of charge by the Crew System Ergonomics Information Analysis Center (CSERIAC). *Editor:* Jeffrey A. Landis; *Copy Editor:* R. Anita Cochran; *Illustrator:* Timothy J. Span; *Layout Artist:* Vicky L. Chambers; *Ad Designer:* Kristen Cheevers.